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WEST COAST FOREST HEALTH MONITORING
EVALUATION MONITORING PROJECT

Aerial Surveys for Swiss Needle Cast in Western Oregon

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Association of
State Foresters

SWISS NEEDLE CAST

In the last decade, Swiss needle cast (SNC), caused by the native fungus *Phaeocryptopus gaeumannii*, has severely damaged Douglas-fir in the Coast Range of western Oregon. The primary impact of the pathogen on Douglas-fir (the only susceptible tree species) is premature loss of foliage, which results in significant reduction in tree growth. Recent reduction in volume growth from SNC in western Oregon likely exceeds 100 million board feet per year.

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AERIAL SURVEY PROCEDURES

Since 1996, annual aerial surveys have been used to monitor the amount and distribution of damage. Flights were made in April and May at 1,500 to 2,000 feet above the terrain, following north-south lines separated by 2 miles. The surveys



The pathogen. Fruiting bodies of *P. gaeumannii* block the stomates on the underside of Douglas-fir needles, interfering with photosynthesis and water regulation.



Foliage condition. Diseased trees lose foliage prematurely (left) compared with healthy trees (right). Diseased foliage often becomes very yellow before it is cast.

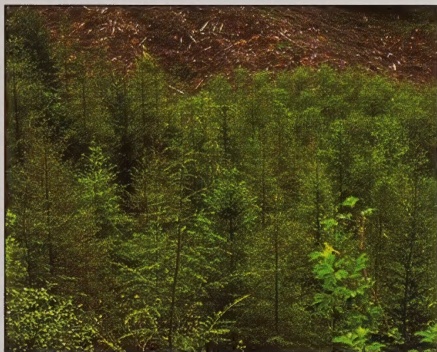


Crown condition.

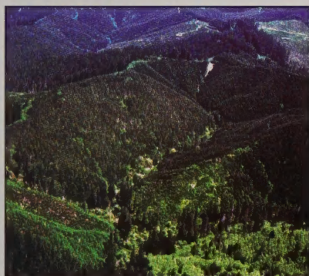
Trees damaged by SNC have sparse transparent crowns and discolored foliage. The disease reduces height and diameter growth.

Appearance of diseased stands.

Diseased stands appear yellow to yellow-brown in spring before budbreak. Sometimes tree crowns are sparse but not yellow, making aerial detection difficult.



covered about 2.9 million acres of forest each year. Observers looked for areas of Douglas-fir forest with obvious yellow to yellow-brown foliage, a symptom of SNC. Patches of forest with these symptoms (the patches are referred to as polygons) were drawn on 1:100,000-scale topographic maps. Sketch maps were digitized and the data analyzed using Arcview software.¹



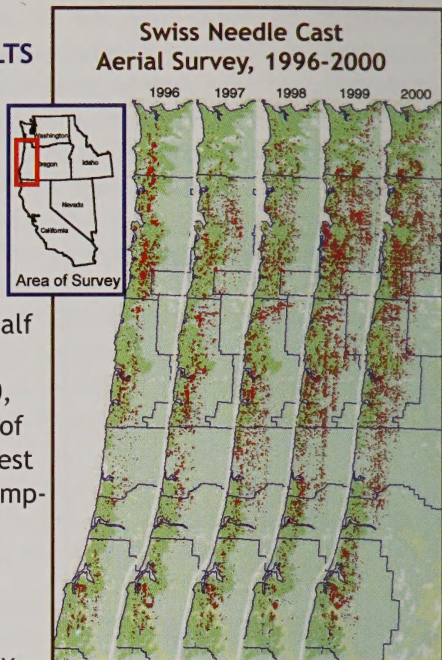
Aerial signature of SNC: Aerial observers look for patches of Douglas-fir forest with yellow to yellow-brown discoloration.

¹ The use of trade or firm names in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service.

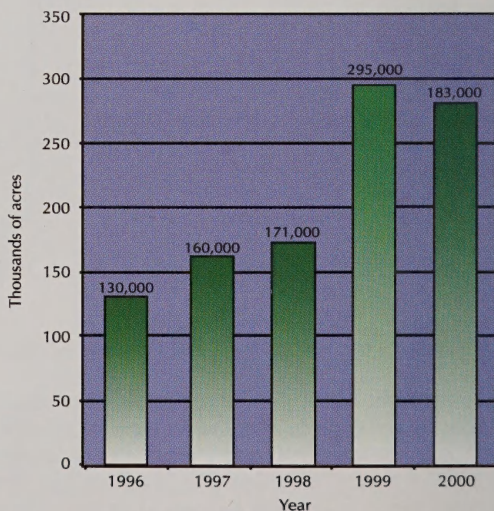
AERIAL SURVEY RESULTS

Five years of surveys reveal that SNC symptoms are continuing to intensify, especially in the northern half of the Coast Range. In 2000, 283,000 acres of Douglas-fir forest had obvious symptoms of SNC, an increase of 100,000 acres compared to the 1998 survey in the same area, but a slight decrease compared to 1999.

The slight decrease in 2000 may not be meaningful because of the inherent variability of the survey and the use of computer-based sketch mapping for the first time in 2000. Symptoms of SNC are now detected up to 30 miles inland from the coast. Most areas with symptoms occur within about 18 miles of the coast, often within the



SNC aerial survey 1996-2000. Maps (one per year) show survey polygons (red areas) of Douglas-fir forest with symptoms of SNC in western Oregon.



Trends in SNC-affected areas. Trends in area of Douglas-fir forest in western Oregon with symptoms of SNC detected by aerial surveys.

Sitka spruce vegetation zone. The widespread planting of Douglas-fir within this vegetation zone, which has a climate favorable to SNC, is an important contributing factor to the recent increase of the disease.

Flights were made over the west slopes of the Cascade Range (more than 70 miles inland from the coast), and few areas with obvious SNC damage were observed. Swiss needle cast is present in the Cascade Range, but damage is not severe enough to be detected from the air.

Did We Map The Same Areas Each Year?

Areas mapped with symptoms in one year were not always detected the following year. When comparing the 1998 and 1999 surveys, about 55,000 acres were mapped in both years. In other words, about 31 percent of the acres mapped in 1998 also were mapped in 1999. When we superimposed the 1998 and 1999 maps, we found that 1,016 polygons overlapped and likely were attempts to map the same area of damaged forest. This represents about 50 percent of the polygons mapped in the 1998 survey. Failure to map the same areas each year is due to timing of the survey (early or late), conditions at the time of the observation flight (clouds can affect color perception), changes in the forest from harvesting, and errors in sketch mapping the precise location of the polygon.

Factors Affecting Survey Results

Survey results differ from year to year because symptoms change rapidly in response to weather conditions before and during the flight period (mid-April through May). Surveys flown later (close to the time of budburst) usually detect more areas with symptoms than those conducted earlier. In 1997, an unusual period of warm sunny weather at the end of May enhanced symptom expression, so we resurveyed a portion of the northern Coast Range. The late survey (May) detected twice as many acres of forest with symptoms as the earlier survey (late April) of the same area. Clear weather is required for flying, but the rainy weather typical of April and May prevents precise scheduling of the survey for the same time each year.



Environment-disease interactions. Symptoms of SNC are most severe on southerly aspects and exposed ridges and on the exposed upper crowns of trees.

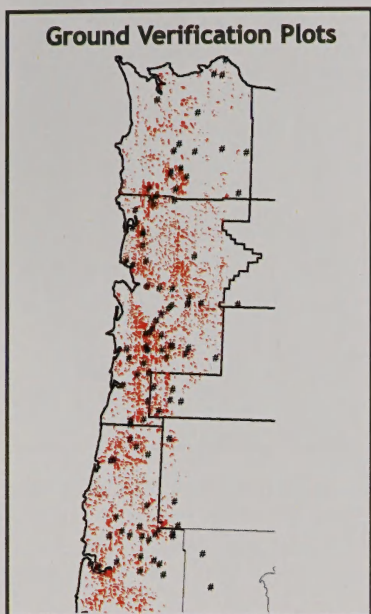
Factors other than the presence of the pathogen strongly affect disease and symptom development, but these factors remain poorly understood. The shape and distribution of survey polygons and the comments of observers suggest that symptoms are most obvious on southerly aspects and on exposed ridge tops, thereby indicating a strong environmental interaction. Observations of ground plots also confirm this. Extreme weather events such as windstorms and unusually low temperatures seem to affect foliage loss and discoloration.

Ground Verification

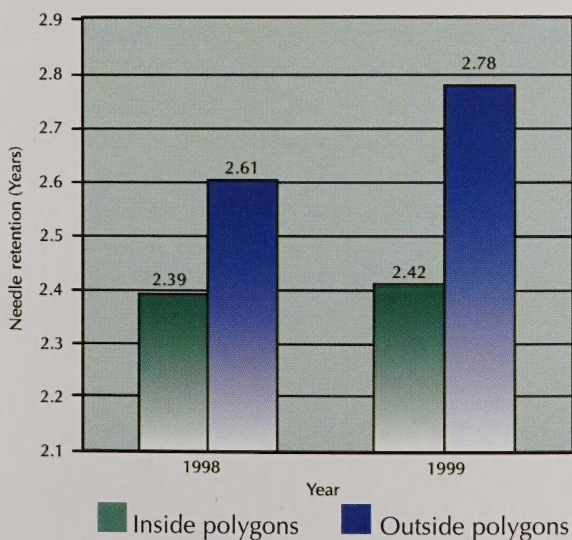
We visited 100 plots located in the northern half of the survey area and compared disease severity ratings of plots that occurred within aerial survey polygons to those that were not in polygons. Swiss needle cast was present and damaging on all plots. Disease severity was slightly greater (significant at the 0.01 level, students t-test) in plots that occurred within aerial survey polygons than in those outside of polygons.

Many more acres of Douglas-fir forest are affected by SNC than indicated on the aerial survey maps. Our maps represent only those areas where symptoms of disease have developed

enough to be visible from the air. Monitoring plots and other ground checks have shown that although damage in an area may be severe in terms of needle loss, it might not be mapped by the surveyors, who depend on discoloration as the main indicator of damage.



Ground verification plots. Location of SNC monitoring plots (black dots) and the 1999 aerial survey polygons (red areas) in the northern Oregon Coast Range.



Needle retention. Mean needle retention for plots occurring inside and outside of aerial survey polygons, northern Oregon Coast Range, 1998 and 1999. Needle retention is the number of annual complements of needles present on lateral branches in May, with a range of values from 0.5 (severely damaged trees) to 3.5 or greater (healthy, undamaged trees).

CONCLUSIONS

- Aerial survey information is most useful for mapping general areas in which SNC is causing significant damage to Douglas-fir.
- Aerial survey maps depict zones in which Douglas-fir management should take into consideration the effects of the disease.
- By overlaying the distribution of polygons with vegetation and topographic maps, the survey also provides some insight into factors that affect distribution and severity of the disease.
- Acreage estimates are useful for documenting trends over time but are not an accurate measure of the true amount of forest with SNC damage.

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